

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
21 December 2000 (21.12.2000)

PCT

(10) International Publication Number  
**WO 00/77301 A1**

- (51) International Patent Classification<sup>7</sup>: D21H 21/14 // 17:14
- (21) International Application Number: PCT/FI00/00532
- (22) International Filing Date: 14 June 2000 (14.06.2000)
- (25) Filing Language: Finnish
- (26) Publication Language: English
- (30) Priority Data:  
991366 15 June 1999 (15.06.1999) FI
- (71) Applicant (for all designated States except US): KEMIRA  
CHEMICALS OY [FI/FI]; P.O. Box 330, FIN-00101  
Helsinki (FI).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): JÄKÄRÄ,  
Jukka [FI/FI]; Koulukatu 32 A 10, FIN-65100 Vaasa  
(FI). PARÉN, Aarto [FI/FI]; Kapteeninkatu 36 B 20,  
FIN-65200 Vaasa (FI).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE,  
DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU,  
ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS,  
LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO,  
NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR,  
TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian  
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European  
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG,  
CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:  
— With international search report.
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD TO IMPROVE THE OPACITY OF MECHANICAL PULP BY USING ALIPHATIC PEROXYACIDS AND USE OF PEROXYACIDS TO IMPROVE OPACITY

(57) Abstract: The invention relates to a method for treating mechanical pulp so that aliphatic percarboxylic acid in the amount of 0.5 - 5 kg/ton of pulp is added to the pulp to improve the opacity.



WO 00/77301 A1

Method to improve the opacity of mechanical pulp by using aliphatic peroxyacids and use of peroxyacids to improve opacity.

The invention relates to a process for treating mechanical pulps, which can be used to affect the opacity of the pulp.

The nontransparent aspect of paper is described by opacity, which, along with brightness, is an important property of pulp in paper manufacture. Almost invariably, however, the opacity of the pulp decreases when the brightness increases. At present, mechanical pulps (refiner mechanical pulp, groundwood pulp, and chemi-mechanical pulp) are more and more often bleached with hydrogen peroxide. Dithionite bleaching is also used either alone or together with peroxide bleaching, whereupon dithionite is either used as refiner bleaching or after-bleaching. In the peroxide bleaching of pulp, mechanical pulp in particular, the decrease of opacity is clearly detectable, while the dithionite bleaching does not necessarily decrease the opacity. Generally, the lighter the level of bleaching the pulp, the lower the opacity of the pulp. The appended Fig. 1 that shows a variation in the opacity of spruce TMP, when peroxide is used to bleach pulp to various degrees of brightness manifests this. In certain paper grades, opacity is an important property. If we want to advance peroxide bleaching at the expense of dithionite bleaching, it would be important to be able to optimize peroxide bleaching so that the opacity remains as high as possible while the brightness grows.

Generally, the chemicals used in the peroxide bleaching of mechanical pulps are hydrogen peroxide, lye (alkali), and waterglass. The purpose of the base is to increase the pH to a sufficiently high level, so that the hydrogen peroxide is dissociated producing perhydroxyl anions. The purpose of the waterglass is to stabilize the hydrogen peroxide bleaching.

It is well known that peracetic acid can be produced in situ, for example, from acetanhydride or TAED (tetra acetyl ethylene diamine) or some other corresponding activator. One disadvantage of TAED is its high price and that it is a solid substance. It would be necessary to disperse the TAED in water before adding it to the pulp, which makes it difficult to use. Furthermore, TAED contains nitrogen, which might constitute a problem for environmental protection. Acetanhydride is relatively cheap, but it would cause odour nuisance and be an inconvenient substance from the point of view of industrial safety. In addition, when fed into an alkaline bleaching solution ( $\text{NaOH} + \text{H}_2\text{O}_2 + \text{waterglass}$ ), it would readily cause silicate precipitate and consume the lye.

Paper manufacture aims at ever-higher brightness levels. The brightness of paper can be affected, for example, by treating the paper with coating agents containing, among other things, pigments, binding agents, and plasticizing agents (JP application 284598).

5 However, the use of several coating agents at the final stage of paper manufacture adds to the manufacturing costs.

The agent that affects the opacity of a technically useful pulp should be liquid and stable, and it should preferably have a suitable pH value, so that no silicate precipitate would form in the bleaching. Because of environmental matters, a nitrogen-free  
10 substance would provide an additional benefit. The additive of the bleaching should also be cost-effective for the paper manufacturers. Consequently, a substance should be found for pulp bleaching, which, to fulfil the conditions mentioned above, is a reasonable, commercial chemical that is easy to get and can be added to the pulp as early as at the bleaching stage. Furthermore, attention should also be paid to  
15 the other effects of the substance, such as applicability in plant conditions.

The purpose of this invention is to find a useful substance that is used in pulp bleaching and that affects the opacity, fulfilling the conditions mentioned above.

The main features of the invention are disclosed by the appended Claims.

Surprisingly, we have now observed that, when a small portion of peracid is either  
20 added to the peroxide bleaching or with the purpose of finishing the peroxide bleaching, the opacity of pulp improves compared with pulp of a corresponding brightness level that is bleached with hydrogen peroxide alone. At the same time, we have observed that peracids scarcely increase the brightness.

The use of peracetic acid in bleaching chemical pulps is disclosed by the published  
25 Japanese application JP 57-21591, for example. However, bleaching processes like this aim at removing the lignin from the pulp and, in this case, the purpose is in no way to adjust the opacity of the pulp.

Tappi publication, Vol. 48, No. 2 (2/1965), W.H. Rapson et al. Paper Bleaching – A New Process, pp. 65-72, discloses a method for bleaching paper by using peracetic acid, among others. However, this method does not aim at improving the opacity of  
30 pulp, but increasing the brightness. Furthermore, the disclosed method uses considerable amounts of peracetic acid, about 1.2 – 2.5% (i.e., 12-25kg/ton of pulp). Such a portion can dissolve a considerable amount of lignin etc. from the pulp, whereupon the paper manufacturing process can be severely disturbed. The publication  
35 also reveals that the technical performance of the method deviates from our invention.

The use of peracids as a biocide is also disclosed by publication Kemia, No. 3 (1995), Jyri Maunuksela, Mikrobieen torjunta peretikkahapolla (Microbe Prevention with Peracetic Acid), pp. 242-244. Such a method aims at destroying microbe populations in the paper machine only. It is self-evident that peracetic acid, which is known to be an effective biocide, prevents the functioning of microbes in the water circulation, if a sufficient amount is present. The method disclosed by the publication uses a so-called equilibrium peracetic acid that contains a considerable amount of free acetic acid and hydrogen peroxide. The acetic acid and hydrogen peroxide that come with the peracid can disturb the paper manufacturing process.

Bleaching methods based on peracetic acid have also been presented, aiming at improving the brightness of the pulp compared with normal bleaching methods. Such a method is presented, for example, by publication Pulp and Paper Magazine of Canada, Convention Issue, 1972, pp. 123-131, and by number 3/1968 of the same magazine in pages 51-60. The doses of peracid used by these methods are very high and, consequently, dissolve a considerable amount of lignin from the surfaces of the fibres. In addition, these methods aim at increasing the brightness of the pulp, i.e. at bleaching.

One difference between the treatments mentioned above and our invention in particular is that the peracid treatments implemented by the means disclosed by them fail to improve the opacity of the pulp; none of the publications mentioned above tried to achieve a considerable increase in the opacity either.

The invention relates to a method, in which the peracid is either added to the peroxide bleaching or, preferably, after the peroxide bleaching, either to the storage tower of the bleached pulp or, for example, among the machine pulp in the paper machine.

Typically, the amount of peracid added to the pulp is about 1-3 kg/ton of pulp. Because of its small amount, the peracid does not dissolve the lignin or the like from the pulp, whereupon it does not disturb the paper manufacturing process. It is especially advantageous to use peracid solutions, which have been purified, so that they mainly contain the peracid in question and water only. In that case, the addition of peracid does not have a considerable effect on the pH value of the stock, and no extra COD gets into the process. The invention differs from the known methods based on peracid namely in that it does not aim at increasing the brightness but growing the opacity. A matter worth noticing in particular is that the method differs from the known bleaching treatments also in that the peracid doses used are very small and the method tries to avoid the dissolution of organic matter from the fibres.

The method is not actually a bleaching method, and the chemicals used in the actual bleaching of the pulp have no effect whatsoever on the functioning of the invention.

The pulp can be bleached with dithionite, peroxide, dithionite and peroxide, or it can even be completely unbleached. Any chelation agents or other additives used in pulp manufacture have no effect on the functioning of the invention either.

The consistency of the pulp at the moment the peracid is added can be 1-40%; the temperature can be 20-100°C. Depending on the process, the pH of the stock can be 3-11, preferably 4-8. If the peracid is added to alkaline peroxide bleaching, an advantageous pH value is 9-11, however. A suitable reaction time for the peracid is 1-300 minutes depending on the process.

The method is well suited to the treatment of mechanical pulp, such as groundwood pulp (SGW, PGW) and refiner mechanical pulp (TMP), or to treat chemi-mechanical pulps (CTMP). The sort of wood used to manufacture the pulp has no importance to the functioning of the invention.

A suitable dose of peracid has been found to be 0.5-5 kg/ton of pulp, typically 1-3 kg/ton of pulp. The peracid used can be any peracid that reasonably dissolves in water. We have noticed that peracetic acid and perpropionic acid are preferable peracids, and especially preferable are the peroxide-free distillates that are prepared from the equilibrium solutions of these. The manufacturing method of peracid has no effect on the functioning of the invention. Peracid solutions that are either purified by distillation or some other method, or the equilibrium solutions of peracids can be used as peracid. Various mixtures of peracids are also usable. One modification of the invention can use a mixture of peracid and Caro's acid.

### Example 1

CTMP pulp was bleached with peroxide in a normal manner. Peracids were added to the bleaching solution, the results are shown in Table 1.

**Table 1**

CTMP, bleaching solution: NaOH 24 kg + waterglass 20 kg + H<sub>2</sub>O<sub>2</sub> 30 kg/ton of pulp, 70°C, consistency 30%, 120 min, chelated pulp, peracid added to the bleaching, PAA = peracetic, PPA = perpropionic acid

	Dosage, kg/ton of pulp	Brightness, % ISO	Opacity
None	-	78.4	64.9
PAA	2	79.1	67.2
PPA	2.2	78.3	70.7

The results show that, by using peracids, a distinctly higher opacity with the same brightness level is achieved than by using peroxide bleaching alone.

**Example 2**

Bleached CTMP pulp was treated with peracids, the results are shown in Table 2.

**Table 1**

Bleached CTMP

5 After-treatment

$t = 50^{\circ}\text{C}$ , 30 min, pH 7, consistency 5%

	Dosage, kg/ton of pulp	Brightness, % ISO	Opacity
None	-	65.9	71.5
PAA	2	66.6	74.1
PPA	2.2	65.8	74.3

The results show that an after-treatment has an obvious effect on the opacity.

**Example 3**

10 So-called machine pulp taken from the plant and containing 16% of softwood pulp, 64% of TMP pulp, and 20% of coated broke (the basic pulp mixture was softwood: TMP 20:80) was treated with peracetic acid. The softwood pulp was normal ECF sulphate pulp. The TMP had been bleached with dithionite. The results are shown in Table 3.

15 **Table 3**

Pulp mixture:

Machine pulp	Softwood pulp	16%
	TMP	64%
	Coated broke	20%

30 min, 70°C, Cs 3.2%, (the test was conducted by using the water of the plant)						
No.	PAA, kg/ton of pulp	pH	TOC, kg/ton of pulp	Brightness, % ISO	Opacity, %	Note!
0	0	5.0	10.4	71.9	91.3	Untreated
1	0	4.9	9.6	71.6	91.8	30 min, at 70°C
2	1	4.6	8.9	71.7	96.5	Distilled PAA
3	2	4.6	9.6	71.9	95.8	Distilled PAA
4	4	4.2	10.2	71.3	96.9	Distilled PAA
5	2	4.5	11.0	70.7	97.1	Equilibrium solution
6	1	5.0	9.5	71.6	93.7	Distilled PAA
7	2	4.9	10.3	71.5	94.4	Distilled PAA
8	2	5.0	10.1	68.8	93.4	Equilibrium solution

20 Distilled PAA = 38% of PAA, 1% of  $\text{H}_2\text{O}_2$

Equilibrium solution = PAA 13%, acetic acid 22%,  $\text{H}_2\text{O}_2$  15%

The results show that the opacity grew considerably because of the treatment with PAA. They also show that the equilibrium solution has an adverse effect on the brightness. The TOC values (total organic carbon) show that the treatment did not dissolve considerable amounts of organic matter from the fibres.



## Claims

1. A method for treating mechanical pulp, characterized in that an aliphatic percarboxylic acid is added to the pulp, in the amount of 0.5 – 5 kg/ton of pulp, to affect the opacity.  
5
2. A method according to Claim 1, characterized in that the amount of aliphatic percarboxylic acid that is added is 1 – 3 kg/ton of pulp.
3. A method according to Claim 1 or 2, characterized in that the aliphatic percarboxylic acid is selected from among performic acid, peracetic acid or perpropionic acid.  
10
4. A method according to any of the preceding Claims, characterized in that the aliphatic percarboxylic acid is distilled or equilibrated peracetic acid.
5. A method according to Claim 1, characterized in that the aliphatic percarboxylic acid is added to the pulp in connection with or after bleaching.
- 15 6. A method according to Claim 5, characterized in that the pulp has been bleached with hydrogen peroxide and/or dithionite.
7. A method according to Claim 1 or 5, characterized in that the aliphatic percarboxylic acid is typically added at a pulp consistency of 1 – 40%.
8. A method according to Claim 1, characterized in that a mixture of aliphatic percarboxylic acid and Caro's acid is added to the pulp.  
20
9. The use of aliphatic percarboxylic acid to improve the opacity of mechanical pulp, in which the amount of percarboxylic acid is 0.5 – 5 kg/ton of pulp.
10. Paper, characterized in being manufactured from pulp treated according to Claim 1.

1/1

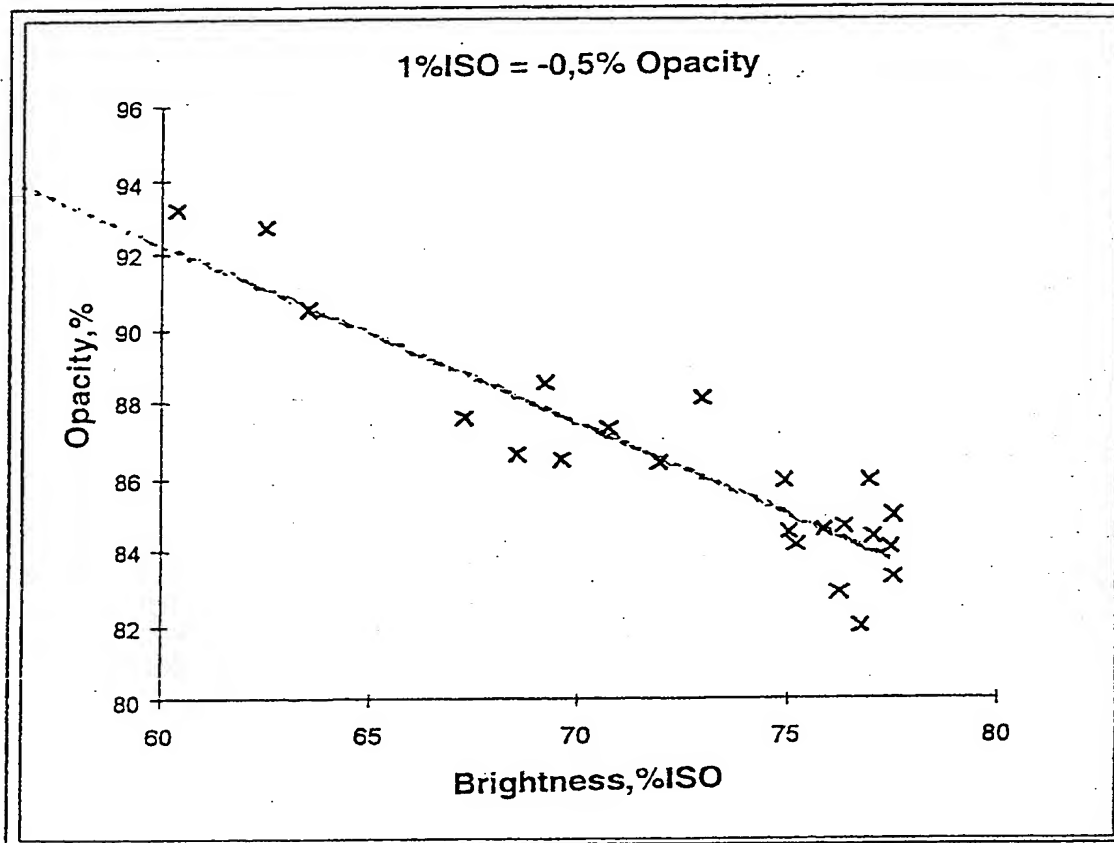


Fig. 1

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00532

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21H 21/14 // D21H 17:14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21H, D21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5693185 A (HOU-MIN CHANG ET AL), 2 December 1997 (02.12.97), column 1, line 61 - line 64, claims 1-5 --	1-10
X	WO 9722749 A1 (KVAERNER HYMAC INC.), 26 June 1997 (26.06.97), see especially example 6, page 15, lines 10-12 and 31-34 --	1-10
X	GB 1119546 A (THE INSTITUTE OF PAPER CHEMISTRY), 10 July 1968 (10.07.68), see claim 1 --	1-8
A	----- -----	9-10

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

15 Sept 2000

Date of mailing of the international search report

22 -09- 2000

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Marie Karlsson/Elis

Telephone No. +46 8 782 25 00

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
**PCT/FI 00/00532**

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
US	5693185	A	02/12/97	AU	672654 B	10/10/96
				AU	5347894 A	12/04/94
				BR	9307066 A	13/10/99
				CA	2141807 A	31/03/94
				EP	0660895 A	05/07/95
				FI	951334 A	21/03/95
				NO	951039 A	17/03/95
				NZ	257205 A	28/10/96
				US	5589032 A	31/12/96
				WO	9406964 A	31/03/94
-----						
WO	9722749	A1	26/06/97	AU	4271596 A	14/07/97
-----						
GB	1119546	A	10/07/68	DE	1692855 A	21/10/71
				FI	48366 B	31/05/74
				JP	54017041 B	27/06/79
-----						